

THURSDAY, SEPTEMBER 27, 1883

HERMANN MÜLLER'S "FERTILISATION OF FLOWERS"

The Fertilisation of Flowers. By Prof. Hermann Müller. Translated and Edited by D'Arcy W. Thompson, B.A., Scholar of Trinity College, Cambridge, with a Preface by Charles Darwin. With Illustrations. (London: Macmillan and Co., 1883.)

CHRISTIAN CONRAD SPRENGEL'S treatise on the structure and fertilisation of flowers, after well nigh a century of oblivion, has come to be recognised as one of the most interesting of books, and his theory of the adaptation of flowers to fertilisation by insects is one that will ever be associated with his name. In the "Origin of Species" Darwin referred to Sprengel's researches, and one of the results of the now well-known Chapter IV. of that great work was to show the value of Sprengel's labours, and this has caused his book to play a prominent part in the investigation of the prime causes which determine the forms of flowers. The idea of cross-fertilisation can scarcely be said to have established itself until 1859, and was a most powerful impetus to research based upon Sprengel's observations. First among the results we had Darwin's own work on Orchids and on plants with heterogynous forms of styles, and attracted by these there came a long line of other more or less able investigators, of whom Hildebrand, Delpino, Fritz Müller, and others may be mentioned—some devoting themselves more to the details of floral mechanisms, others to the proof of the advantages of cross-fertilisation. More comprehensive were the views of Hermann Müller, who, in 1872, published his important "Befruchtung der Blumen durch Insekten und die gegenseitigen Anpassungen beider." In this the author's aim was to consider each case of cross-fertilisation in all its possible bearings, the advantage to the flower and to the insect, and how the one in its contrivances to assure its ends acted and reacted on the other; there was the evolution of the powers of the insect step by step with some advantage to the plant. Naturally the scheme was too vast, too grand to be entirely accomplished through the labours, direct or indirect, of any one man; and, so far as regarded anthophilous insects, Hermann Müller chiefly confined his attention to the bees, describing the modifications which fit them for a floral part, and proving that such modifications had been gradually evolved. This work of H. Müller's has been the guide-book of a host of workers during these last eleven years, and we most cordially greet its appearance now in an English translation by Mr. D'Arcy W. Thompson. The very recent death of its painstaking and worthy author adds a peculiar interest to its publication; in it he has incorporated all his most recent observations, so that it is not only a translation but a new and importantly enlarged edition—a monument to his fame. We regret that the translator did not think fit to give us the author's preface, which, though but four pages, contained much of practical interest, gave us an insight into Müller's labours as a teacher of natural science in the High School at Lippstadt, and would have been a worthy affix to the genial prefatory notice of

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Charles Darwin. One other regret and we are done. Why are the modest but pregnant words on the title-page of the original nowhere alluded to in the translation? This work, for which Darwin felt grateful—this book containing "an enormous mass of original observations on the fertilisation of flowers and on the part which insects play in the work," we quote again Darwin—the author himself styles "Ein Beitrag zur Erkenntniss des Ursächlichen Zusammenhanges in der Organischen Natur," but the translation says nothing of this.

So far as we have been able to judge, the translation has been most successfully accomplished, but a great deal of new material has been added. Some of the original is omitted, and many new figures have been introduced. The systematic part of the book, most happily for the reader, has been rearranged from Endlicher's system to that of Bentham and Hooker's "Genera Plantarum." The translator, disliking the word "pollination" as a translation for "Bestäubung," "has throughout [not quite] used the word 'fertilisation' to imply application of pollen to the stigma, without definite reference to the result of the act; that is to say, he has translated 'Bestäubung' and 'Befruchtung' by the same English word." We would have much preferred the use of the "ungainly" word, though possibly a more gainly one might have been invented. For it is awkward in a scientific treatise to refer to a sterile fertilisation (Bestäubung), while a sterile besprinkling or dusting of pollen would sound no way queer; the two functions of besprinkling and fertilising at any rate are distinct, and we should have some way of saying so. The list of all works relating to the subject is a very important addition to the book, and the copious and well compiled indices deserve our grateful thanks. The translator's acknowledgments to his friend the assistant curator of Cambridge University Herbarium reminds us that not only since these pages were sent by him to press have Darwin and Hermann Müller ceased from their labours, but that Mr. T. H. Cory of Caius College has, in the very first promise of his career, and while in the pursuit of the very flowers he loved so well, fallen a victim to a boating accident, and added one to the memories that will cling around this volume.

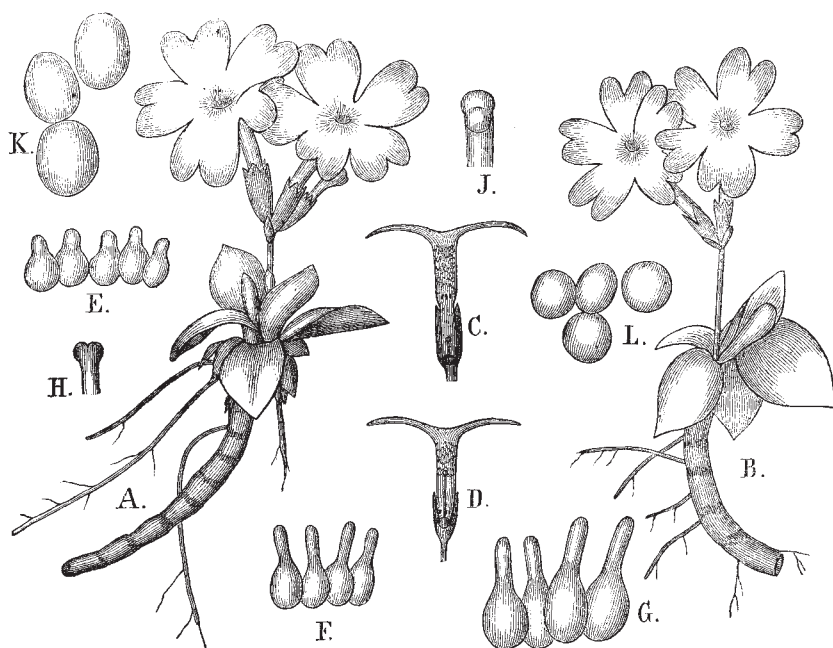
As an example of the illustrations we are enabled to give the accompanying woodcut of the pretty Alpine Primrose (*Primula integrifolia*). It is one of the red-flowered heterostyled species, and is adapted for Lepidoptera by its colour and the narrowing of the mouth of the tube. It will be remembered that the species of primrose were the subject of a series of interesting researches by Darwin which showed that in the common Primrose (*P. veris*) the stigma in the long-styled form possesses papillæ three times as long as those of the short-styled form, and that the pollen grains of the long stamen are half as large again as those of the short. The same holds good of *P. auricula* and *P. sinensis*, and these Primulas are very unproductive in the absence of insects, but fully productive when artificially fertilised or when insects have access to them.

The last few pages of this translation treat of the subject of the origin of flowers, which has chiefly been discussed by Hermann Müller, since the appearance of the first edition, in a series of essays, several of which appeared from time to time in these columns, tracing

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the first appearance of vegetation to aquatic forms. With the change to dry localities, from the vascular Cryptogams seem to have been developed wind-fertilised unisexual flowers—thus first the Gymnosperms, and from these afterwards the Angiosperms have arisen. Finally from the wind-fertilised Angiosperms entomophilous flowers arose; insects came first accidentally and afterwards regularly to seek their food on flowers, and natural selection fostered and perfected every change which favoured insect visits, and thereby aided cross-fertilisation. With the transition to insect-fertilisation came on the one hand great economy of pollen, but on the other hand the uncertainty of insect visits made it as a rule necessary that self-fertilisation should remain possible. Thus, though descended from unisexual (anemophilous) ancestors, entomophilous flowers are usually hermaphrodite, and are capable to a great extent of ferti-

lising themselves when insect visits fail. But in the course of further development many of them have so increased their means of attracting insects (by colour, perfume, honey, &c.) that the power of self-fertilisation has become superfluous, and finally has been lost. Insects, in cross-fertilising flowers, endow them with offspring, which, in the struggle for existence, vanquish those individuals of the same species which are the offspring of self-fertilisation. The insects must therefore operate by selection in the same way as do unscientific cultivators among men, who preserve the most pleasing or most useful specimens, and reject or neglect the others. In both cases selection in course of time brings those variations to perfection which correspond to the taste or to the needs of the selective agent. Different groups of insects, according to their sense of taste or colour, the length of their tongues, their way of move-



Primula integrifolia, L. A.—Short-styled, B.—Long-styled plant (nat. size). C.—Short-styled, D.—Long-styled flower in section (nat. size). E.—Stigmatic papillae of short-styled flower. F, G.—Ditto of long-styled flower. H.—Stigma of short-styled flower, I.—Ditto of long-styled flower ($\times 7$). K.—Moistened pollen of short-styled flower, L.—Ditto of long-styled flower.

ment, and their dexterity, have produced various odours, colours, and forms of flowers, and thus have flowers and insects progressed together towards perfection. All this leads on to the final proposition with which this general retrospect ends, that the forms, colours, and odours of the flowers in a particular region must depend in the closest manner upon the insect fauna of the region, and especially upon the relative abundance of the various classes of insects in it.

The whole subject of the fertilisation of flowers is one of still unexhausted resources. The student will in this volume have references to what is known, and will find out easily the immense amount of details still waiting investigation. An almost new subject is one that has been lately referred to in our columns by Prof. A. W. Bennett, on the constancy of insects in their visits to flowers; and several new lines of research are pointed out in Mr. Darwin's preface. It is a subject within the reach of all

honest, patient observers. It is limited practically to no clime and season. Some of Müller's observations were made on flowers grown in windows, and all were carried on amid the somewhat scant leisure of a busy professional life.

LETTERS TO THE EDITOR

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[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Iguanodon

SINCE I wrote the account of M. Dollo's researches on Iguanodon, which appeared in NATURE of September 6 (p. 439), I have had the advantage of some conversation with Prof. Marsh